

Lead Poisoning: An Overview of Bagega Gold Mining Village in Zamfara State, Nigeria

A. M. Haidara

Department of Biological Sciences Usmanu Danfodiyo University, Sokoto, Nigeria
mhaidaraa@gmail.com

A. Mudansiru

Department of Biological Sciences Usmanu Danfodiyo University, Sokoto, Nigeria
mudahn@gmail.com

A.S. Muhammad

Department of Biological Sciences Usmanu Danfodiyo University, Sokoto, Nigeria
deeqsa14@gmail.com

M.S. Yakubu

Department of Science Laboratory Technology Umaru Ali Shinkafi Polytechnic Sokoto, Nigeria
murinsani@gmail.com

Abstract-Environmental pollution is found in every part of the globe, the intensity varies with region and nature of pollutant bagega town has its own share of this problem. Lead is a metal that has no known importance in system of human being, this element is found naturally in the environment in an amount acceptable by regulatory agencies, but with illegal exploration of natural resource the concentration of this element is elevated in both water, air and soil and this result in significant impairment of the environment there by causing various degree of damage and even death in some instance. The increase in concentration of this metal in Zamfara State is associated with prolific artisanal gold mining and other mineral resource under the soil. Despite the effort being made to remediate the environment by government there is need to create awareness on the effect of this metal and government should provide them with modern equipment in mining process.

Keywords: Lead, Zamfara, Artisanal mining and Heavy metal.

I. INTRODUCTION

In March 2010, the humanitarian organization Medecins Sans Frontieres discovered an unprecedented epidemic of lead poisoning in remote villages of Zamfara State, Nigeria [28]. The first set of children brought to MSF clinics with convulsions and high fevers were treated for severe malaria and meningitis. As patients failed to recover, blood samples were sent to a German laboratory and they confirmed lead poisoning [28]. Extensive health and environmental assessments in two villages, Dareta and Yargalma, documented 163 deaths, including up to one third of children under age five [14]. Subsequent surveys of six additional villages showed >17,000 people were severely exposed and an estimate of 400 to 500 children had died of acute lead poisoning [27, 14, 50].

In most mining areas of Nigeria where illegal mining is commonly practiced, the interaction of solid minerals and the water sources is inevitable. Hence, water bodies such as rivers and lakes are used in floatation to separate the ore after crushing. The mining region of Northern Nigeria is known since the colonial era. The popular among them is the Jos and in late 70's the Zamfara mining belt. The Zamfara mining region has deposits of precious metals like tantalite and gold among other [4].

II. SOURCES OF LEAD POISONING IN BAGEGA

Lead exists in the Earth's crust, mainly as lead sulphide, and occurs naturally in the Environment through a variety of mechanisms including volcanic emissions, geochemical weathering, sea spray emissions, and re-mobilization of historic sources such as lead in soil, sediment, and water from mining areas [51, 8]. However the major source of lead contamination in Zamfara was prolific artisanal gold mining in response to high gold prices in 2009-10. For several months, ore processing was conducted at sites within Daretta and Yargalma. Gold ore, sourced from mines throughout Zamfara State, is crushed by hand to gravel consistency using scrap hammers or mortars and pestles, ground to a fine powder in modified flour-mills, sluiced by water to separate heavy particles, amalgamated with mercury, and burned over open flame to obtain a low grade "sponge" gold that is sold to local traders for eventual refining for Dubai or Chinese markets. Grinding produces large quantities of dust, which settle on soils and surfaces. Sluicing results in water source contamination and large piles of ore tailings. Because of religious and cultural practices include sequestration of married women, ore crushing, washing, and gold recovery were undertaken within the homes "residential compounds" to utilize the women's labor. During the rapid increase in mining activities, a vein of ore exceeding 10% lead (Pb) was processed, resulting in severe residential exposures [38]. By April 2010, local Emirates suspected a link to children's mortality and ordered artisanal ore processing operations moved approximately one-half kilometer from the villages. Extremely hazardous processing wastes and contaminated soils (>3% Pb) remained in the compounds and public areas [50].

III. HEALTH, ENVIRONMENTAL, AND GENDER IMPACTS OF ARTISANAL MINING ACTIVITIES IN BAGEGA

Since the 2010 lead poisoning outbreak in zamfara, much attention has been given to the collateral health and environmental impacts that arise from artisanal mining. While the zamfara outbreak shifted much of the focus of the impacts of artisanal mining lead, mercury poisoning is an equally important concern. Artisanal mining is currently the largest contributor towards global anthropogenic mercury emissions, responsible for 37% of all such emissions [4]. These emissions are also rapidly growing; from 2005-2013, mercury emissions doubled, causing total land and water emissions to exceed 800 tons per year. Factoring in air emissions, some estimates place the total figure as high as 1600 tons per year, although this may simply reflect more accurate reporting [9].

A. Health Impacts

The health impacts of both lead and mercury are not immediately noticeable and manifest themselves over time. A comprehensive review of scientific studies indicates that artisanal mining communities experience neurologic and kidney effects, as well as possible immunotoxic/autoimmune effects from mercury exposure [10]. For both mercury and lead poisoning, the health effects are more pronounced in young children. Extreme exposure can lead to coma or even death [10]. For women, exposure to mercury positively correlates with an increase in malformations and miscarriages during pregnancy [11]. Many women have also reported menstrual cycle disorders [12]. Mercury is used in artisanal mining to amalgamate the gold and separate it from the fine-grained material. The residual mercury attached to the gold is later burned off and released in vapor form, which can be easily inhaled by people in the vicinity [13].

B. Environmental Impacts

In addition to the health impacts described above, mercury and lead also impose detrimental environmental impacts. Up to 95% of mercury used in artisanal mining is released into the environment [14]. Dredging and sluicing during mining also cause severe land degradation and river siltation. The increases in suspended sediment from river siltation hinder the penetration of light into the water and greatly affect the supply of nutrients [15]. The suspended sediment also tends to carry high concentrations of mercury. A recent UNEP report predicted that warmer temperatures induced by global climate change would increase rates of organic productivity and bacterial activity in water that could trigger a more rapid conversion of mercury to methylmercury, its more potent form [16]. During periods of heavy rain, the lead can leach into groundwater systems, contaminating them in the process [17]. Lead dust can also affect animals grazing nearby in many of the same ways it affects humans [18]. Artisanal mining activities cause other environmental harms, such as the destruction of natural habitats at mining and waste disposal sites. All the aforementioned environmental impact was reported in the mining areas of Bagega and other villages surrounding it.

C. Gender Impacts

Around 30 percent of the global workforce of artisanal miners is composed of women, with the highest percentage (40 to 100 percent) found in Africa [19]. Because of their involvement in artisanal gold mining, particularly gold processing, women and their children working in artisanal gold mining are susceptible to their own set of health concerns. Generally speaking, women face the greatest risks from carrying heavy materials, washing ore in contaminated water, and becoming exposed to chemicals when burning gold amalgam [20]. Likely afflictions for women and children working in or around mines include gastroenteritis, lung inflammation, respiratory infections, spinal, joint, neck and back damage, frequent cuts and bruises [21].

Women in Zamfara had taken an active role in processing gold in residential compounds, using mortars and pestles that they used to prepare food. Even where women are not directly involved in Artisanal mining activities, they may still play a role in influencing mining practices and the use of mercury [20].

1. IV. REMEDIATION EFFORTS TO CURTAIL THE LEAD POISONING AT BAGEGA

In response to a request for technical assistance from the Zamfara Ministry of Health (ZMoH) and the Zamfara Ministry of Environment and Solid Minerals (ZMoE), NGO Terragraphics (TG) and Blacksmith Institute (BI) developed an emergency remediation plan that was initiated in June of 2010 at the villages of Dareta and Yargama in Anka and Bukkuyum LGAs. This work is known as Phase 1 of the overall remediation program and was conducted under a series of protocol documents negotiated with the ZMoE entitled “Emergency Cleanup Strategy for The Villages of Dareta and Yargama, Zamfara State, Nigeria –Lead Poisoning Epidemic – June 2010” [22].

The Phase I cleanup work was conducted by the ZMoE with the technical guidance and assistance of TG. The work was funded by a combination of Zamfara State, TG and BI. The cleanup continued until work was suspended due to the onset of the rainy season in mid-July. As a result of Phase 1 activities, MSF was able to provide chelation treatment for nearly 1000 children commencing in mid-June and continuing through the rainy season [22]. At the end of the remediation exercise a total of 282 residential compounds, 107 exterior areas and 23 processing ponds have been remediated in the Bagega and other villages around it. a large landfill has been constructed and prepared to accept contaminated soils and industrial waste; and residential areas, common area village exteriors, brick-making ponds and the Bagega Industrial Site have been characterized [23].

V. IDENTIFICATION OF PRINCIPAL EXPOSURE ROUTES

The response action undertaken in Bagega Lead Remediation Project by Blacksmith Institute was based on this successful US model of health intervention, emergency removal, advocacy, clinical treatment, and follow-up [24]. All of the measures aim to reduce exposure to the population by reducing the intake of lead along the main exposure routes. A similar pathways model was utilized in Zamfara, identifying and removing soil/dust pathways to mitigate lead exposures [22]. The primary exposure routes for children and adults identified in the village are [23].

- 1) *Incidental ingestion of contaminated soils and dusts.*
- 2) *Consumption of food contaminated by soil and dust sources.*
- 3) *Ingestion of contaminated water.*
- 4) *Inhalation of contaminated dusts*

VI. SOME CHALLENGES FACED BY AUTHORITIES IN BAGEGA POISONING

- 1) *Lack of access to the villages around Bagega due to road damage and water bodies that isolated some villages.*
- 2) *Unexpected degree and severity of contamination within compounds and processing areas.*
- 3) *Unanticipated security lockdowns associated with local elections/bandit in zamfara state.*
- 4) *Difficulties and delays in procuring affordable rates for heavy equipment [25].*

VII. OVERVIEW OF SAFER MINING TECHNOLOGIES TO PREVENT THE RE-OCCURRENCE OF THE POISONING

Lead exposure can also be minimized through alternative processing technologies along with safer practices [26]. In areas where the soil contains high concentrations of lead, lead exposure is triggered by the milling of gold ore, which liberates both gold and lead from the minerals and rocks contained in the soil [27]. The dry milling process is the most prevalent practice and produces significant amounts of lead dust, which can be breathed in by miners and others in the area, and carried home, on clothing, food, and equipment. Wet milling machines greatly reduce the level of dust produced, minimizing exposure pathways for lead contamination. Even with wet milling machines, safety equipment is still needed to prevent low levels of lead exposure. Converted flour mills traditionally used for corn and millet are sometimes used as a dry milling method [27].

The Safer Mining Program led by the Ministry of Mines and Steel Development (MMSD) in early 2013 has been taking steps to increase the availability of safer mining technologies in high-exposure areas in Zamfara and elsewhere. In September 2013, the federal government received a delivery of iGoli and wet milling machines from the South African government for Zamfara [28]. While there are technologies available to reduce or eliminate mercury use that do not compromise or that can even improve yield or cost, many challenges exist in getting miners to actually adopt new technologies. The failure of assistance programs has been attributed to a range of factors, including [29]:

- 1) *Introduction of technologies which require special technical knowledge or frequent maintenance in order to achieve acceptable economic returns.*
- 2) *Provision of technologies without mechanisms for financing.*
- 3) *Lack of consideration for the socio-cultural context, gender-differentiated roles, the organization of labor, and geo-climatic conditions (e.g. related to the availability of water).*
- 4) *Inadequate training in the use of technology.*
- 5) *The imposition of technologies on miners who have not participated in their selection or development.*

Despite awareness on the part of some miners of the health and environmental risks associated with their trade, they have continued with their practices due to economic constraints. Hence, unless safer technologies are demonstrated to be effective and made more accessible (both financially and geographically), it is unlikely that wide-scale adoption will be seen.

VIII. CONCLUSION

Based on the review conducted, the artisanal gold mining exercises in Bagega and environs are likely to have immediate and long term health risks to the exposed populations if left unchecked. The hazard is not limited to the miners only, due to unprofessional practice of the miners, the villages and its visitors may be equally at risk.

IX. RECOMMENDATIONS

- 1) *The Government should devise a means to monitor and oversee artisanal and small-scale mining activities.*
- 2) *The legal requirement that artisanal miners form co-operatives in order to obtain a mining license and assistance from government should be reconsidered.*
- 3) *Educate miners about the environmental impacts of mining activities and importance of environmental protection measures, as well as resources available to help them comply with environmental requirements.*
- 4) *Government might also wish to consider establishing/ reactivate gold processing centers to showcase and enable miners to use improved processing technologies.*
- 5) *Local advocacy efforts in the villages need to be continued and enhanced.*

REFERENCES

- [1]. MSF. 2011. Field Journal: Nigeria. Available: <https://www.doctorswithoutborders.org/publications/alert/article.cfm?id=5013&cat=alertarticle> [accessed 11 February 2014].
- [2]. Dooyema, C.A., Neri, A., Lo, Y.C., Durant, J., Dargan, P.I., Swarthout, T., et al. 2011. Outbreak of fatal childhood lead poisoning related to artisanal gold mining in northwestern Nigeria, *Environmental Health Perspective*. 120:601-607; doi:10.1289/ehp.1103965.
- [3]. MSF. 2010. Nigeria: Lead poisoning continues to affect hundreds of children in northwestern Nigeria. MSF Can. Available: <http://www.msf.ca/news-media/news/2010/10/nigeria-leadpoisoning-continues-to-affect-hundreds-of-children-in-northwestern-nigeria/> [accessed 31 January 2014].
- [4]. Von lindern, I., von Braun, M., Tirima, S. and Bartrem, C. 2011. Zamfara, Nigeria Lead Poisoning Epidemic Emergency Environmental Response, May 2010 - March 2011, Final Report to the United Nations Children's Fund (UNICEF). Available: http://media.wix.com/ugd/f467ea_79df307f6de84f47b430e1bafcdc90f3.pdf [accessed 15 December 2015].
- [5]. Alhassan, Y., Tsafe, A.I., Birnin Yauri, U.A., Okunola, O.J., Yargamji, G.I., Yebpella, G.G. and Ndana, M. 2010. EDXRF analysis of tantalite deposit of Mai-Kabanji, North-Western Nigeria, *Journal of Environmental Chemistry and Ecotoxicology* 2(6) Pp 185-188 Available online <http://www.academicjournal.org/jece>
- [6]. WHO 2010. Exposure to Lead: A Major Public Health Concern. Geneva, World Health Organization.
- [7]. Cheng, H. and Hu, Y. 2010. Lead (Pb) Isotopic Finger Printing and its Application in Lead Pollution Studies in China: A Review *Environmental Pollution*. Pp 1134-1146.
- [8]. Plumlee, G.S., Durant, J.T., Suzette, A.M., Neri, A., Wolf, R.E., Dooyema, CA, et al. 2013. Linking geological and health sciences to assess childhood lead poisoning from artisanal gold mining in Nigeria. *Environmental Health Perspective* 121: 744-750.
- [9]. United Nations Environment Programme, Second Global Forum on Artisanal and Small Scale Gold Mining (2013). http://www.unep.org/chemicalsandwaste/Portals/9/Mercury/GF2/NewFolder/Global%20Forum_II_meeting%20report.pdf
- [10]. Gibb, H. and Leary, K.G. O. 2014. Mercury Exposure and Health Impacts among Individuals in the Artisanal and Small-Scale Gold Mining Community: A Comprehensive Review, *Environmental Health Perspectives* <http://dx.doi.org/10.1289/ehp.1307864>
- [11]. Agency for Toxic Substances and Diseases Registry 2007. Lead Portal (note 8).
- [12]. Gerhard, I. 1998., Heavy Metals and Fertility, *journal of toxicology and environmental health*, Part A, 54:593-611.
- [13]. Human Rights Watch, Protecting Child and Adult Gold Miners Against Mercury: A Right to Health Issue 2011, <http://www.hrw.org/news/2011/10/17/protecting-child-and-adult-gold-miners-against-mercury-right-health-issue>. Accessed, November, 2016.
- [14]. Telmer, K. and Stapper, D. 2012. Reducing Mercury Use in Artisanal Mining. Artisanal Gold Council British Columbia.
- [15]. Global Alliance on Health and Pollution, 2000. Promoting Mercury-Free Artisanal Gold Mining Practices in Indonesia, http://www.gaahp.net/new/wpcontent/uploads/2013/04/GAHP_Indonesia-pilotproject-firstreport.pdf.
- [16]. UNEP Global Mercury Assessment 2013.
- [17]. U.S. EPA, 2003. Human Health and Lead, <http://www.epa.gov/superfund/lead/health.htm>

- [18]. Agency for Toxic Substances and Disease Registry, Interaction Profile for Toxic Substances: Lead, Manganese, Zinc, and Copper (2004) <http://www.atsdr.cdc.gov/interactionprofiles/IP-metals1/ip04-a.pdf>
- [19]. Kaiser, A. 2010. Gender Analysis. *Psychol J.* 220, 130-136.
- [20]. Eftimie, A. 2009. Gender Dimensions of the Extractive Industries: Mining for Equity, Extractive Industries and Development Series #8 (The World Bank 2009).
- [21]. Telmer & Stapper, Reducing Mercury Use in ASGM (note 13).
- [22]. Blacksmith Institute (2014). Environmental Remediation - Lead Poisoning in Zamfara State, Nigeria. Fifth Avenue, New York. Available at www.blacksmithinstitute.org accessed on 14th March, 2016
- [23]. Girigisu, S., Ibeanu, I. G. E., Adeyemo, D. J., Onoja, R. A., Bappah, I. A. and Okoh, S. (2013). Assessment of Radiological Levels in Soils from Bagega Artisanal Gold Mining Exercises at Bagega Zamfara State, Nigeria. *Arch. Appl. Sci. Res.*, 5 (3), pp. 204-210.
- [24]. Galadima, A. and Garba, Z. N. (2012). Zamfara Lead Poisoning. *Elixir pollution*, 45, pp. 7917-7922.
- [25]. TerraGraphics Environmental Engineering, Inc. (2011). Zamfara, Nigeria Lead Poisoning Epidemic Emergency Environmental Response – UNICEF Final Report. Washington DC
- [26]. Environmental Law Institute (2014). Artisanal and Small-Scale Gold Mining in Nigeria: Recommendations to Address Mercury and Lead Exposure. E.L.I.®, Washington, D.C.
- [27]. TerraGraphics Environmental Engineering, Inc. (2010). Health and Safety Manual and Health and Safety Standard Operating Procedures. Washington, D.C.
- [28]. Ugeh, FG Receives Machines for Safer Mining (note 23).
- [29]. Hinton, J., C. Beinhoff, Report to the UNEP GC Meeting, Nairobi, February 2005, on Mercury and Artisanal Gold Mining (Global Mercury Project report to the U.N. Environmental Program Governing Council Meeting, Nairobi, Kenya, February 2005), at 13. [Short cite: —Report to the UNEP GC Meeting]